Ohio Agricultural Experiment Station.

BULLETIN 72.

WOOSTER, OHIO, AUGUST, 1896.

Peach Yellows, Black-Knot

AND

San José Scale.

SPECIAL BULLETIN

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BULLETIN

OF THE

Ohio Agricultural Experiment Station.

NUMBER 72. August, 1896.

PEACH YELLOWS, BLACK-KNOT AND SAN JOSÉ SCALE.

INTRODUCTORY NOTE.

BY THE DIRECTOR.

Section three of the recently enacted Yellows—Black-Knot law, reprinted herewith, requires of the Ohio Experiment Station the publication of a bulletin, "that shall plainly give full and complete information regarding the causes, symptoms, devastating effects and cure or treatment of peach yellows, black-knot, San José scale, or other serious contagious diseases of fruits, in sufficient quantity to supply every grower of fruit liable to these diseases, in the State."

Since no special appropriation was made for the publication of this bulletin, it is issued as one of the regular series of the Station's bulletins.

The bulletin has been prepared with special reference to the needs of practical fruit growers, and therefore has been limited to a brief discussion of such points as have been shown by experience to be serviceable in the control of the diseases and insect pests referred to.

It has been prepared hastily, in order that it might reach the peach growers, especially, in time to enable them to detect all trees affected with yellows, from the unfailing symptoms of the fruit—the promise of a general peach crop being unusually good.

SYNOPTIC INDEX.

PEACH YELLOWS AND BLACK-KNOT.

By Augustine D. Selby, B. Sc., *Botanist.*

PEACH YELLOWS.

Yellows is a contagious disease affecting the peach and closely related fruits. It attacks almond, apricot and nectarine trees and has been known to appear in Japanese plum trees. It seems to be confined to America and the United States. The peach is the only of these as yet known to be affected with yellows in Ohio. It is with the manifestation in this fruit only, that this paper shall have to do.

Great misapprehension exists with respect to peach yellows. The color idea is seized upon quite frequently to the exclusion of the other symptoms. The term "yellows" is a misnomer as commonly accepted. The real indications, the unfailing signs of this disease are, for the ordinary observer, not yellow color. The grower is, therefore, asked in the beginning to lay aside the notion of color as the distinguishing feature, and to view the name of the trouble as a convenient one to apply to the particular disease, but as far from meaning that every yellow looking peach tree is affected with true yellows. While yellow color of foliage is found in cases of peach yellows, this is far from the rule in that stage of the disease which it is to the best interests of all to recognize. The earliest symptoms in well nurtured trees are almost entirely without this feature. Yellow foliage is found in badly nurtured trees, be the cause what it may. Those suffering from yellows show the lack of normal green color somewhat in proportion to the impairment in vigor.

The facts of occurrence, distribution and local damage due to yellows in the State have been secured by field study in the affected districts. The symptoms have been carefully noted, and where possible, the progress-

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Note: Dr. Erwin F. Smith has made a special study of peach yellows. He is authority upon yellows. The following publications prepared by him will give detailed studies of the trouble:

Peach Yellow: A preliminary report, Bull. 9 Div. of Botany, U. S. Dept. Agric., 1888.

Additional Evidence on the Communicability of Peach Yellows and Peach Rosette, Bull. 1 Div. Vegetable Pathology, U. S. Dept. Agric., 1891.

The Chemistry of Peach Yellows, I and II Proc. American Pomol. Soc., 1889 and 1891.

Experiments with Fertilizers for the Prevention and Cure of Peach Yellows, Bull. 4 Div. Vegetable Pathology U. S. Dept. Agric., 1893.

Peach Yellows and Peach Rosette, Farmers Bull. 17, U. S. Dept. Agric., 1894.

ive spread observed. The symptoms discussed have long been recognized and give nothing previously unknown, as may be said of all the matter set forth. The object of this publication is to enable growers to recognize the yellows, where present, and thus be prepared to co-operate in measures for its repression.

DISTRIBUTION OF YELLOWS.

Yellows in peaches is known to occur in many counties of Ohio and may be expected in many others, from which definite information of its presence has not yet been obtained. Affected trees have been examined in the counties of Ottawa, Sandusky, Erie, Lake and Athens, and are reported in Cuyahoga. The distribution in these counties, where exami-

FIG. 1. DISTRIBUTION OF PEACH YELLOWS IN OHIO.

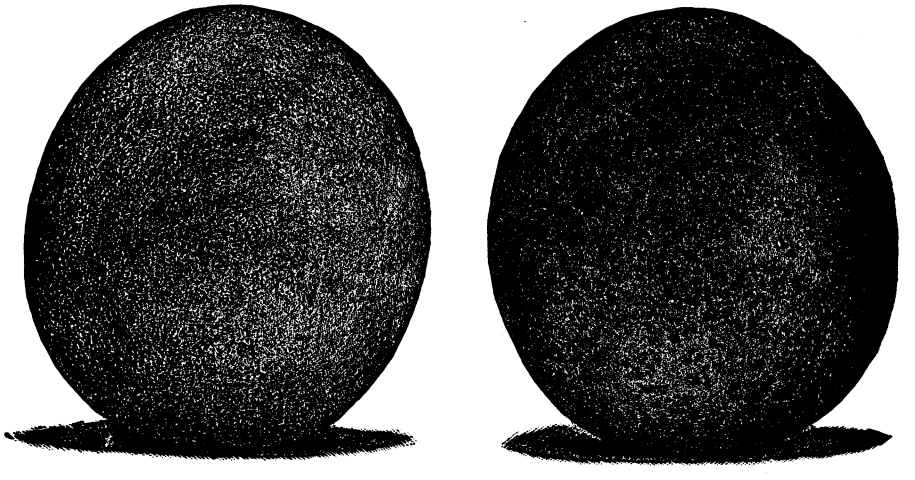
nation has been made, with the exception of Athens, is shown in the accompanying map. With respect to Athens county the disease seems to be generally present over it.

Within the United States, yellows occurs in all the states east of the Mississippi and north of the northern boundaries of Tennessee and North Carolina, excepting Wisconsin, and possibly some of the most northern of the New England states. It is widespread[1] in Delaware, Maryland, New Jersey, New York, Connecticut, Michigan and Pennsylvania.

SYMPTOMS OF YELLOWS.

The peculiar and characteristic symptoms of yellows are: 1. The premature ripening of the fruit, which is abnormally colored and spotted and has its flesh marbled with red. 2. The premature development or unfolding of ordinary winter buds. This may extend to the fruit buds as well, and in case of the leaf buds may take place as early as June or be delayed until slightly in advance of proper time in the following spring. It occurs very commonly in August, September and October. 3. In addition to the development of buds out of season, resting buds or buds newly formed sprout from the bark of the trunk and branches and grow into shoots having well marked characters.

The ripening of premature fruit may precede the normal ripening by only a few days, or by five or six weeks, or possibly longer. The red spots occur on the skin (Fig. 2) and in the flesh. They may be well shown,



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1. Healthy Peach. 2. Yellows Peach.

Fig. 2. Appearance of healthy and diseased peaches. (Cut from photograph by U. S. Dept. Agriculture).

[1] See Farmers' Bulletin No. 17, U. S. Dept. Agric., 1894, p. 6.

in the flesh, by thin slices cut obliquely from the side of the peach. The fruit itself is, almost without exception, inferior in quality, tending to be insipid or bitter.

This premature ripening is often the first symptom of yellows, and in all cases where it occurs accompanied by the red spotting or marbling, just described, it is conclusive evidence of the presence of the disease. Where the premature ripening is the first symptom, the peaches are of good size, very showy, and occur upon branches bearing abundant green foliage and also other fruit which, later, ripens in the normal manner. In first year cases, only the fruit of a single branch or single twig on a branch may exhibit these symptoms; yet the whole tree is incurably affected. In second or third year cases the foliage is generally abnormal, and the peaches are commonly quite small, and yet more deficient in flavor. To one familiar with the premature yellows peaches there is no difficulty in distinguishing yellows fruit in the packing house or upon the market. The enforcement of the statutory provision against such fruit seems, therefore, entirely practicable.

The premature development of buds upon yellows trees is also thoroughly characteristic. This is best studied in August, September and October. Fig. 3 will give an idea of the appearance of some of these shoots, with winter buds, unfolding in autumn. Affected trees, three years old, near Willoughby, O., were observed in bloom November 1, 1896. This fall blooming was there limited to yellows trees, it has not been observed in bearing trees. Many stages of the branching, and consequently many forms in the shoots result from this premature bud development. It gives rise to thin, wiry growths from the fruiting branches and, in later stages, the multiplication of shoots is very conspicuous. In trees of the third or fourth years of the disease, similar to those in Plate I, this is very well shown. It gives what is properly called a broom-like growth; the twigs are slender and wiry, the leaves are narrow and reduced, while the foliage upon such is yellow in color and the whole growth is generally feeble in appearance.

It is perhaps most satisfactorily studied in the first and second years of yellows upon the water sprouts or shoots springing from the trunks and larger branches. These growths more properly belong under the third class of symptoms as given above. When a single branch of the tree ripens premature, yellows fruit, these water sprouts are frequently present. Near the bases they may exhibit normal branching and normal colored foliage, but at the summit so many buds develop and grow with slender, wiry shoots that a dense cluster of slender twigs is produced—a veritable broom.

For practical discrimination between yellows trees and those not diseased, all of the symptoms mentioned are used and should rightly be considered. Beginning with the ripening of the fruit, when trees are bearing, and running on until frost causes the leaves to drop in November,

FIG. 3. WINTER BUDS UNFOLDING IN AUTUMN. (After Smith.)

one or more of these characteristic symptoms may be found in affected orchards. The premature, spotted fruit alone may be regarded as conclusive evidence when unaccompanied by any of the other symptoms. The premature development of winter buds is not likely to occur largely where a crop of normally ripened peaches has been gathered from every portion of the tree during the same season. It is in cases where trees are not in bearing or where the crop of fruit has already been gathered and knowledge of its character, as to maturity, is not at hand, that exclusive reliance must be placed upon this premature bud development and wiry twig or broom growth. These are likewise entirely sufficient symptoms upon which to base condemnation of the trees in question. The point

to be noted, however, is that they are less striking evidences to the ordinary observer than the premature fruit. Although less striking they are not the less valuable.

DISEASES MISTAKEN FOR YELLOWS.

Yellows is a specific trouble, and it is necessary to state what it is not. Peach borers, root aphis, galls upon roots or crown, root decay, wet subsoil, starvation as in peat or quartz sand and other conditions may lead to symptoms likely to be confounded with yellows.

The peach borer, larvæ of an Ægerian moth (*Sannina excitiosa* Say) is a common trouble of exasperating persistence, especially in sandy or loose soils. The borers girdle the trees, which may show yellowing and premature ripening of fruit. The girdling, with the larvæ usually present, may be disclosed upon examination.

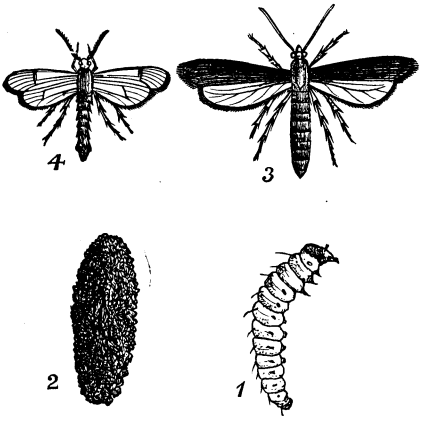

FIG. 4. THE PEACH TREE BORER. 1. Larvæ. 2. Pupa. 3 and 4. Adults. (After Smith.)

The premature fruit from trees suffering from borers is nearly normal in color and flavor and has not the mottled color with marbled flesh occurring in yellows. The bud and twig symptoms are lacking. Where the two diseases occur together the exact symptoms due to each may not be easily separated.

Root aphis or root louse (*Aphis persicæ-niger* Smith) sometimes attacks the roots and more commonly the roots of trees planted one or two years. They cause stunted growth of slender twigs, while the premature development of buds is not present as in yellows. The lice, which are dark in color, resemble those upon cherry leaves. They may be observed frequently upon the peach leaves, accompanied by ants. Examination of the roots may likewise disclose them.

PLATE I. ADVANCED STAGE OF YELLOWS IN PEACH TREES AMONG RASPBERRIES. Berlin Heights, O., August, 1895.

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Root or crown galls, knot-like developments upon the stem, at or above the surface of the ground, and upon the roots, or root decay, usually end in more or less sudden collapse of the tree. The difinitive symptoms of yellows do not occur. Wet subsoil frequently produces trees with yellowed foliage, and temporary excess of water in clay situations may result in the death of the tree. These, likewise, are not yellows and lack the symptoms that have been stated for that trouble. Starvation is not yellows, and as far as we know yellows is not starvation. This phase of the question is too extended to be treated here.

FIG. 5. PEACH LEAF CURL. (After Smith.)

The curl of the peach leaves caused by the distorting effects of a fungus, *Exoascus deformans* (B) often results in the yellowing of the diseased leaves. This is especially the case during June when the curled leaves are dropping or ready to do so. Because of leaf yellowing, leaf curl is mistaken for yellows. The figure in the text, Fig. 5, will show the ordinary form of curled leaves, which have none of the aspects of leaves on yellows trees, being full in size, although greatly thickened, corrugated and distorted.

HOW YELLOWS IS SPREAD.

Yellows is rightly regarded as a contagious disease. While Dr. Smith[2] has not been able from his extended investigations to discover a

[2]Smith, E. F., loc. cit., p. 10.

particular organism or contagium in cases of yellows, no one familiar with its spread in affected orchards would question its contagious character. Aside from this, the many inoculations, resulting in the production of yellows by the use of buds from yellows trees or by the introduction of pieces of diseased tissue into healthy trees, leaves no room for doubt of its communicability. The cause of peach yellows is still undetermined, and with this the specific contagium remains unknown. But that yellows spreads from affected trees to healthy trees is not to be disputed, except upon stronger evidence than has been heretofore adduced.

Where yellows appears on young trees, and especially in regions previously free from the disease, the nursery is rightfully suspected. The use of apparantly healthy buds from trees which exhibit symptoms of yellows upon any part, has been shown by experiment to produce the same malady. These experiments show also that the disease may remain dormant for some time in the buds and afterwards appear on trees grown from them. In districts badly affected with yellows the likelihood of getting diseased buds is greatest, and the danger of infected nursery stock is most evident. The danger from buds is well known and well proven, yet local circumstances lead to the belief that it has often been overlooked. Trees which have ripened premature fruit have been used as a source for cions in budding. It is not necessary to restate the danger which this sort of anxiety to secure a new variety may involve.

In localities where yellows are known to prevail there is spread of the disease in some other way than by budding or planting affected trees. In some affected districts yellows makes a clean sweep and many of the trees carried away have borne normal fruit for years after coming from the nursery. That such previously healthy trees contract yellows, leads to the conclusion that the causes must exist in the locality. Unfavorable local conditions of soil and climate appear, from observation and experiment, not to be able to give rise to yellows in the absence of other diseased trees. The conclusion is, therefore, forced upon us, that the trees contract yellows from neighboring trees already affected by the disease. The facts of inoculation, previously stated, may be cited as conclusive evidence upon this point. The same inference is thrust upon us inevitably in studying yellows in affected districts. The pruning knife and diseased pollen have been cited as a means of transmitting yellows. To quote from Dr. Smith[3], "All that is definitely known is that the disease is communicable by bud inoculation; that trees with the soundest constitution are subject to it; and that it is like an infectious disease, its first scattered appearance in a locality being followed, after a longer or

[3] Smith, E. F., lot. cit., p. 10.

shorter interval, by the occurrence of cases in many orchards and this stage by the rapid destruction of the orchard."

CAUSE OF YELLOWS.

About all that can be said under this head has already been given. Yellows is a physiological disease in which all the tissues of the plant become involved. By buds from infected trees we transmit this diseased condition and inoculate healthy trees. The affected tissues, in this case, act as the cause. But back of this we cannot, at present, go. The specific characters of the disease enable us to know that the disease exists. The facts of observation and experiment demonstrate that it is transmitted, that it spreads. While it would be gratifying to be able to go further, our knowledge does not permit. Nor does this question of cause affect in any way the practical problem of dealing with the disease. Sufficient experience has been acquired since the disease appeared in the United States, about one hundred years ago, and sufficient has been added to this by the experiments made, to give the information upon which to act.

Many sides of this question of cause have been discussed, and some of them, no doubt, find current acceptance. It has been claimed that yellows arises from soil exhaustion, from climatic conditions, such as autumn frosts, severe winter, excessive rainfall, and from other causes. These have all been studied by the United States Department of Agriculture, through the agent previously quoted, and the results of these investigations have been published and are accessible. Perhaps the one claim that finds largest favor is that with respect to the relation between yellows and the deficiency or exhaustion of lime and potash from the soil.

Very careful experimentation, running through a period of years and made in different localities, failed to give any indication favorable to the view that there is any such relation. Treatment for prevention by the use of fertilizers failed to prevent the disease. There are abnormalities in yellows that lend color to this view, particularly ash composition. In yellows there is an abormal ratio of ash constituents; potash and phosphoric acid are in excess and lime is deficient. It is far from my purpose to assert that the use of fertilizers in orchards is not attended with good results. The application of phosphoric acid and potash, particularly, and of limited quantities of nitrogen, is likely to give return in the crop, but that this application will in any way check, cure or prevent yellows, seems to be entirely without experimental foundation.

EFFECT OF YELLOWS.

The ultimate effect, in case of trees affected with yellows, is the death of the trees. The disease may run its course in a longer or shorter pe-

riod, depending on many factors, the characters of which are not understood, but sooner or later the tree succumbs. Moreover, from the experience of fruit growers in Michigan and other peach districts, they have come to recognize periods of greater virulence, when yellows rages more fiercely than in other years. Such periods would show more rapid destruction of diseased orchards than the periods of quiescence. This perhaps refers, in a greater degree, to the number of trees requiring removal each year than to the rate or course of disease in individual trees. Trees attacked by yellows die in from three to six years and exhibit the stages of disease somewhat in the order given. The adventitious shoots, the growth of adventitious buds or the premature ripening of fruit, mark the earlier stages, while dying branches, yellowed and stunted foliage, dense and wiry twig growths, and conditions of evident decay and approaching death, follow in second, third and subsequent years.

The rate of spread will be affected by the periods of virulence and probably by other conditions, but more effectively by the treatment the diseased trees receive at the hands of the grower. Prompt removal and burning of affected trees as they show symptoms of yellows, will exert a decided influence upon the rate of spread. It is not safe for the growers of any section of the State to rely upon immunity from yellows, for in this they are almost certain to be disappointed. Yellows attacks trees on all soils and under all conditions of cultivation and vigor, and the trees once attacked may not be saved by cutting off the diseased branches or by any other treatment. Delay in applying the only known means of check only increases the danger of spreading. In sections where the yellows has appeared in the State, the orchards have generally been swept away, and later, when the devastation was completed, new planting was again undertaken. This was more or less the case about Willoughby, Lake county, where the disease appeared late in the sixties, and the same state of things has been repeated about Berlin Heights, Erie county, and near Clyde, Sandusky county.

It seems highly probable from observation that there will be a difference in spread in different localities in the same year. How far this may be influenced by conditions purely local, it is impossible to assert. Neglected yellows means, to me, devastated orchards for all sections. And while the rate of spread and length of time for the undesirable end may vary, the end appears to be the same where neglect of preventive measures is the rule. That the damage due to yellows, where care is taken to remove diseased trees promptly, is likely to exceed the losses from other equally well known causes, I very much doubt. It would seem from present observations that with proper care the losses from yellows might not largely exceed those recently suffered from borers.

But these observations have been made during a short period when the virulence of the disease may have been less marked than in other periods in other localities.

TREATMENT FOR YELLOWS.

Since yellows is a contagious disease, transmitted by proximity of diseased and healthy trees, as well as by inoculation, and since all direct application of remedies has proven valueless to cure or ward off yellows, the measures remaining to the grower are only preventive or palliative ones. They are measures that may stay the spread of the disease, but are in no wise cures for trees once attacked. When a tree is once affected with this disease, it has passed the saving stage; it can not be cured; it can not prove a profit in the orchard; it is only a source of further disease, scattering the pestilence by which it is doomed. It has been found that, by prompt removal of affected trees, and their destruction by fire, the rate of spread may be checked. One locality practicing this removal and burning may be able to go on in successful peach growing, while another, in which neglect prevails, suffers an entire destruction of the industry. The trees are removed that the source of infection may cease. But this alone does not appear to be sufficient. The removed trees should be burned to destroy existing disease.

Yellows trees should, therefore, be removed root and branch and reduced to ashes. This removal should be prompt, and the burning should be done as near as possible to the point of removal. It seems to be well proven that dragging diseased trees through the orchard is a source of contagion.

To show that this preventive destruction is sufficient to hold the disease in check, the experience of certain Michigan districts may be cited:[4]

"In confirmation of this belief in axe and fire, we have the experience of the Michigan peach growers. In some localities, notably at South Haven, they have been fighting the disease in this way for the last twenty years, and though the extermination of affected trees has not been complete, the results have been of such a nature as to lead the growers to believe that this annual weeding out has saved the orchards. Of several facts there can be no doubt, and it is difficult to draw from them other than one inference. First: This disease appeared at South Haven as long ago as 1869 in a few trees of a single peach orchard, becoming generally disseminated within five years and so destructive as to seriously threaten the prosperity of the peach growers. Second: The disease has not given serious trouble since the growers first began to wage their war of extermination, the extent of the orchards to-day being greater than formerly and their health and productiveness unimpaired. Third: There have been cases of yellows in this region every year since its first appearance, and the diminished prevalence is not

[4] Smith, E. F., pp. 11–12.

easily attributable to other agencies, because in neighboring localities, where no effort has been made to stay the progress, the disease has prevailed extensively during this period, even to the destruction of all the orchards and the abandonment of peach culture in some regions. Even at South Haven there is evidence that a few years of general neglect would result disastrously, one or two men in recent years having neglected or refused to destroy affected trees, and the orchards immediately surrounding these have subsequently shown a larger number of cases than those in other parts of the district.

"At South Haven and other places where the law is maintained it is customary to keep the orchard full by planting young trees in place of those removed. There are many such trees now in bearing and entirely healthy, although set in the very places occupied by diseased trees, and only a few months after their removal. Such 'replants' sometimes develop yellows, but from an experience of many years the growers have learned that the disease does not show any decided preference for such trees. They are not immediately attacked and are not more subject to it than others. At St. Joseph, Mich., where yellows appeared in 1866, and all of the orchards were finally destroyed, many new orchards cover the old fields. These have been planted during the last ten years, and many are now in bearing. Nearly all of these trees are healthy and the cases of yellows that have appeared in the last few years are apparently attributable to neglect of destroying old cases rather than to any inability of the soil to bear healthy trees. It must be said, however, that there has not been here that general interest in the subject which is manifest at South Haven. There have been a few cases of yellows in a good many orchards, and there is every reason to think that history will soon repeat itself in Berrien county unless the law is rigidly enforced."

In these Michigan districts the growers report a decreasing number of new cases of yellows each year, with prompt removal of all diseased trees as fast as these exhibit the symptoms. It is further held that trees planted in places of those removed by reason of yellows are less liable to take the disease than the trees surrounding them. Removal and burning of all yellows trees is our present reliance to check the disease.

THE OHIO STATUTE.

The yellows law will be found reprinted in another place. It appears to be adequate for the check of yellows in the state. The real test of use is yet to be made, although there is little difficulty to apprehend. The chief complaint seems to be of the township trustees, and dereliction on their part can surely be reached in the township which chooses them.

BLACK-KNOT.

Black-knot is a fungus disease of native origin, which attacks plums and cherries, both wild and cultivated. It is a most serious trouble in the cultivation of these fruits. It differs from yellows in the more striking symptoms of disease. These symptoms are the enlargements, excrescences or knots upon the affected trunk or branches, which are the only parts attacked. It does not attack apple trees or raspberry plants.

It is necessary in the study of black knot to distinguish between the old and the new knots, and to distinguish between the beginning stage, in

which no insects participate, and the final stage of the knot in which it furnishes a harbor for several insects. There is no question whatever as to the fungous nature of black-knot. The knots themselves vary in size and shape, some extend entirely around the twig; some affect the branch in a part of the circumference only; some grow where there are no branches, and others form in the forks of branches. These knots may either be the result of a single year's growth, or may be from continued growth during two or more seasons. The surface of the old knots is covered with a black, wavy crust, and the interior is usually more or less insect-eaten. The knots are very conspicuous after the leaves have fallen, but must be studied through the season in order to get at their mode of formation and cause.

HOW A KNOT IS FORMED.

Each knot has its beginning in a spore, which is cast from some older knot. This spore, finding lodgment upon a twig, branch or within a fork formed by two branches, grows, and the threads produced by its growth penetrate the bark. As the growth of these threads advances there is a swelling of the attacked twig, followed by a cracking of the bark. This cracking brings to view the knotted surface covered with the olive threads of the fungus, bearing multitudes of spores. This stage is commonly observed in May and is marked by the olive-colored, velvety-appearing coating of the new enlargement. These summer spores, as we may call them, are carried by the wind and the rain, and where they find lodgment and germinate, may form other new knots, but are not capable of surviving the winter in our climate.

As the season advances the new knots loose their olive appearance. They become dark and later black in color, having a papillate or warty appearance. Each wart-like elevation may develop into a spore case containing numerous small sacks. Each of these sacks contains, when fully developed, eight spores, known as asco-spores or resting spores. These are not matured until late in the winter, about February. Later the spore cases burst open, the spores are discharged and are scattered by the agencies before mentioned, probably by the birds also. They are now ready to germinate with the first favorable conditions of warmth and moisture. Each of these spores is capable of giving rise to a new knot, and the cycle of a knot formation is continued.

It should not be inferred, from what has been said, that the fungus forms the knot. The irritation of the growing threads of the fungus causes the multiplication of the cells of the twig in contact with them, and this cell multiplication in turn forms the knot.

EFFECTS OF BLACK-KNOT.

It has been stated that the knots often surround the twig entirely, in which case the portion of the twig or branch beyond the knot soon dies. With the destruction of the twigs and smaller branches, larger and larger branches are attacked and finally the whole tree is destroyed. The number of cherry and plum trees destroyed in Ohio during the past twenty years is enormous, and there is no hesitancy, on the part of one familiar with this destruction, in asserting that the danger of black-knot, when neglected, is very great. With increased attention to plum and cherry growing the number of trees subject to attack grows yearly and the necessity for preventive measures yearly increases.

DISTRIBUTION AND IMMUNITY.

Black-knot occurs all over the State of Ohio, and I believe in all the states of the Union. It, no doubt, locally exhausts itself by exhausting the hosts, that is, by killing off the supply of susceptible plum and cherry trees. Nevertheless, it is rarely absent from any locality. Black-knot attacks the wild species, of cherry especially, and these may be the means of harboring the disease when cultivated sorts are not at hand.

Practically no variety of cultivated cherry or plum is immune from black-knot, but there are marked differences in susceptibility of varieties. It has been observed many times that the Damson plum and the Morella cherry succumb before some of the other varieties, yet where these other varieties grow constantly exposed to the infection of black-knot spores, they are almost certain to be attacked by the disease. The immunity of particular varieties is not a question for extended discussion here, but he who bases his plans entirely on current claims of immunity of particular varieties is very likely to be disappointed. The only safe plan appears to be in the method of destruction as hereafter stated.

CAUSE AND SPREAD OF BLACK KNOT.

Black-knot is caused by a fungus, *Plowrightia morbosa* (Schw). The life history of this fungus has been pointed out in connection with the description of forming knots. The fungus lies over winter in the form of the resting spores or asco-spores before described. It is spread each spring by the asco-spores. These spores constitute the contagium of black knot, and since they constitute the means by which the disease is spread, the prevention of black-knot must depend upon their destruction. This may be done in two ways: either by cutting off and burning the knots before the spores escape, or, by spraying the trees and thus killing the spores after they have escaped from the knots, or after they have partially grown.

TREATMENT OF BLACK-KNOT.

The first method stated for destroying the spores is, from present knowledge, the cheapest and most effective. It is the one insisted upon by our State law, and the one best adapted in general to the prevention of black-knot. The remedy then is, to *cut off and burn all knots as soon as found, and under no circumstance to delay the removal and destruction later than February.* Where small twigs or branches are affected, it is best to cut off these twigs or branches about two inches below the knots and burn them. In case of very large branches, where they are but partially surrounded, the knot may be cut out with a suitable tool and burned. The effort in this case should be directed to the removal of all the spongy tissue around the knot, and the wound should be coated over with paint. This treatment is sufficient to hold black-knot in check, and indeed, to stamp it out, provided it be applied equally to wild growths in any region.

The best time to destroy knots is when they are discovered. If they are removed in May or June, the chances for new knots are reduced, since the summer spores are destroyed. After the leaves have fallen, the knots may be removed any time before March, and better earlier, to insure the results desired. Where the number of branches to be cut off does not make a serious menace to the tree, the time of year is of relatively less importance; but where a large proportion of the branches are affected, it may be better to cut down the whole tree and make a bonfire of it. Kerosene oil or even crude petroleum may destroy black-knot, where directly applied, yet the remedy is expensive and leaves the dead twigs to be removed. This coal oil treatment can scarcely be counted as destruction in the statutory sense.

OTHER SERIOUS CONTAGIOUS DISEASES OF FRUIT TREES.

In comparison with yellows and black-knot there are few other diseases of fruit trees equally destructive. There are other troubles, however, that are serious or promise to become so, although the contagious nature of some of them is inferentially rather than directly proven. The common fungus diseases affecting leaves and fruit, as apple scab, peach, plum and cherry rot, peach scab, pustular spot of the peach, bitter rot of apples and some others, while contagious in the same sense as black-knot, may not apparently be so effectively handled by preventive measures. They are treated of in other bulletins of the Station and do not seem to require detailed mention here.

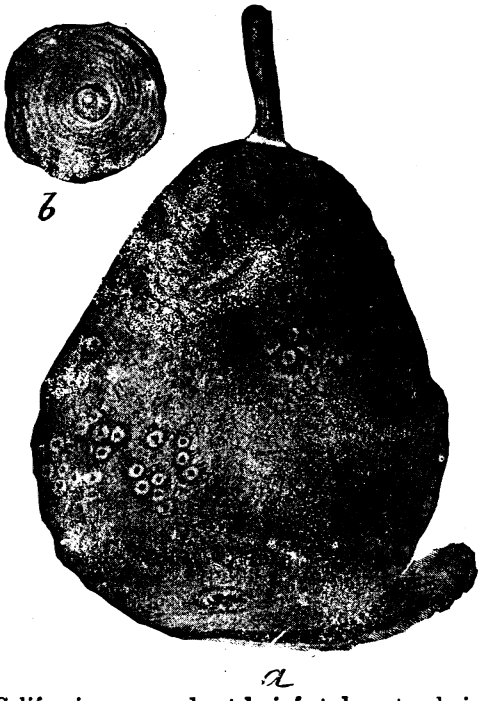
ROOT OR CROWN GALL.

There is one trouble of apple, cherry, peach, and some other trees, that may properly claim a place in this discussion. I allude to the root or crown gall of these trees, which also affects raspberry canes. This appears as knots or enlargements from one-half inch to three inches in diameter, that come upon the roots of the trees or upon the stem near the surface (at the crown). It frequently occurs upon trees from the nursery. Apparently this disease is contagious, although the evidence is as yet largely inferential. We know, however, that affected trees will, in nearly all cases, soon die. The destruction of affected trees by fire should accordingly be required. Trees grown alongside of affected ones can not at present be condemned.

THE SAN JOSÉ SCALE, (*Aspidiotus perniciosus* Comstock).

By F. M. Webster, *Entomologist.*

The wording of the act passed by the last legislature of Ohio, relating to contagious diseases of fruit trees, and further known as House Bill No. 580, which requires the Ohio Agricultural Experiment Station to issue a bulletin of information on the subject of Peach Yellows, Black-Knot and San José Scale, leaves considerable latitude to the discretion of those upon whom the duty of its preparation has devolved. I take it for granted, however, that it is not a wordy, technical treatise that is wanted,

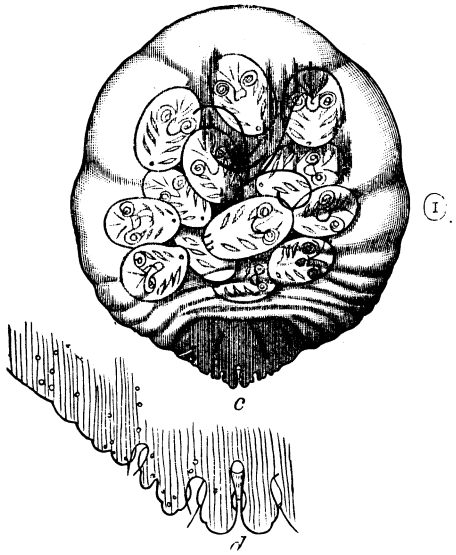


San José Scale.—*a*, California pear, moderately infested—natural size; *b*, female scale, upper side—enlarged.

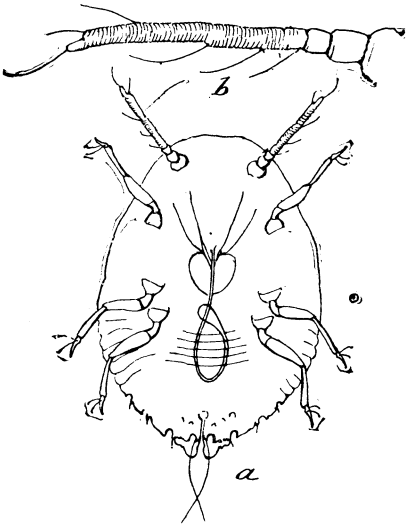
but a plain, concise explanation of the nature and habits of these pests, with details and technicalities alike reduced to the minimum. In short, it is expected that this publication shall be such an one as shall enable the grower of fruits to readily detect the presence of these insects and diseases on his premises, and, temporarily at least, take the place of expert and final decision, in cases of disagreement between the fruit grower and township fruit commissioners.

DESCRIPTION OF SCALE.

The female scale is flat, almost circular in outline, dark mottled with gray color, with a small elevated spot at or near its center which is black or yellowish; it measures about one-sixteenth of an inch in diameter, but under favorable conditions may attain to the size of one-eighth of an inch. The fully developed female can only be observed by removing the scale with which it is covered at a time when she is just about to give birth to her young. She will have then lost both her legs and antennæ, being now only provided with a long delicate proboscis consisting of four threadlike bristles encased in a two-jointed sheath. The body is almost transparent, and the young can be clearly distinguished within.



Under side of San José Scale.—*c*, adult female containing young—greatly enlarged; *d*, anal fringe of same—still more enlarged.



Under side of San José Scale.—*a*, young larvæ—greatly enlarged; *b*, antennæ of same—still more enlarged.

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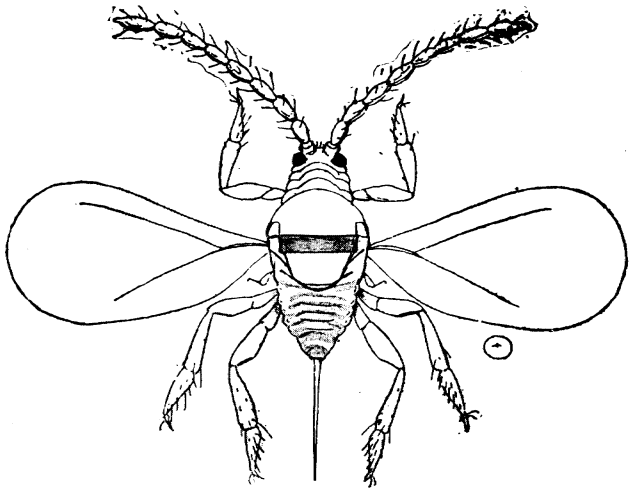
The male scale is black and somewhat elongated when fully formed. It is often oval in shape, smaller than the female and more abundant. The larval skin is covered with a secretion, and its position is indicated by a single, nipple-like elevation between the centre and anterior margin of the scale. The fully developed male only has wings. The body is of a light amber color with dark brownish markings, and terminates in a slender stylet as long as the body. It is, however, too minute to be of interest to any but naturalists, having to be always examined with a microscope.



San José Scale--**Male** adult—greatly enlarged.

Younger and smaller scales are darker in color than the older and larger ones, and sometimes appear quite black; while on the other hand, those that are just set may be white or yellowish. When occurring in winter upon the bark of a twig in large numbers, the scales lie close together, frequently overlapping, and are at such times difficult to distinguish without a magnifying glass. The general appearance which they present is of a grayish, very slightly roughened, scurfy deposit. The rich, natural, reddish color of the twigs of peach and apple is quite obscured when these trees are thickly infested, and they have then every

San José Scale.—Apple branch with scales as they appear in winter—natural size; enlarged scales above, at left.

appearance of being thickly coated with lime or ashes. Even without a magnifying glass, however, the presence of the scale can be readily noted if the twig be scraped with the finger nail, when a yellowish, oily liquid will appear, resulting from the crushing of the bodies of the insects.

The insect itself belongs to a group known as armored scale insects, its nearest ally being the oyster-shell bark-louse, while still farther removed are the mealy-bugs. We have here in the east a somewhat similar species that I have found on peach, plum, pear and maple. This is known as the Putnam scale (*Aspidiotus ancylus*), having been first described by the late J. Duncan Putnam, from Iowa. It is known to occur on the following plants also: ash, beech, bladder-nut, hackberry, linden, oak, osage-orange and water locust. This is often mistaken for the San José scale, even by those who are quite familiar with the latter. My own manner of distinguishing between these two scales is to first observe if the disk is circularly wrinkled and the elevation in the centre surrounded by a depressed ring; if the scale is very flat, or if it appears to raise gradually from the outer edge to the base of the elevation; if the scales are disposed to crowd in compact patches. If the disk is circularly wrinkled with a deeper ring about the base of the elevation; if the scales crowd each other closely over large areas and give the tree a gray appearance, it is probably the San José scale. If the disc is smooth, and the central point rises out of a smooth area, it is probably the Putnam scale. Still, it is difficult to give any absolutely "hard and fast" rule for separating these two, without a very critical examination, and in such cases it is always best to refer to expert authority before taking decisive action.

The San José scale differs from all others in the peculiar reddening effect which it produces upon the skin of the fruit and of the inner bark of young trees or tender twigs. This very characteristic feature of the insect's work usually renders it easy to distinguish. Around the margin of each female scale is a circular band of this reddish discoloration, and the cambium layer of a young twig, or on young trees, where the scales are massed together, frequently becomes deep red or purplish. Small spots on fruit produced by a common fungus, (*Entomosporium maculatum* Lev.) sometimes so closely resemble the spots made by the scale as to require close examination with a lens. It also sometimes happens that the Putnam scale will cluster on young apple trees where the outer covering or *skin* of the bark is reddened, and it must be remembered that it is not this but the *inner* bark that has the stained appearance. I have seen the two species of scale each about as thickly clustered on trees, but the Putnam scales are usually much less closely placed, and

where much scattered are usually larger than the San José scale. Another scale that has come to me several times as the San José scale, is the Oleander scale, (*Aspidiosis nerii*) which also attacks ivy. But this is of a lighter color, flatter and larger. The Rose scale, (*Diaspis rosæ*) has been sent me, both on the rose and raspberry, with the query as to whether or not it was the San José scale. But this is also larger, more depressed and of a lighter color. In short, we have nothing of this sort but the Putnam scale that clusters so thickly together on the host plant and gives it that peculiar gray color, which once seen will never be mistaken for anything else, and none that gives the peculiar discoloration to the inner bark.

LIFE HISTORY.

In regard to the life history of the species now under consideration, it appears to differ from that of many of our scale insects in that, instead of reproducing by laying eggs, the mother gives birth to her young. Wintered-over females continue to give birth to living young day after day for six weeks. This condition of affairs produces, early in the season, a confusion of generations, which makes observations upon the life history of the insect extremely difficult and only to be accomplished by isolation of individuals. It also seriously complicates the matter of remedies, since, as numbers of the larvæ are hatching every day, and as they begin to form their almost impervious scales in two or three days, a spraying operation at any given time will destroy only those larvæ which happen to be at that time less than three days old, while on the day after the spraying new larvæ will be born to take the place of those just killed. Observations upon isolated individuals show that the newly-hatched larvæ, after crawling about for a few hours, settle down and commence at once to form a scale. The secretion is white and fibrous. In two days the insect becomes invisible, being covered by a pale, grayish-yellow shield, with a projecting nipple at the center. This nipple is at first white in color.

The males have large purple eyes, while the females have lost their eyes entirely. The legs and antennæ have disappeared in both cases. Six days later the males begin to change topupæ, while the females have not yet cast the second skin. At this time the females are so tightly cemented to the scale that they cannot be moved without crushing. In two or three days more, or twenty to twenty-one days after hatching, the females cast their second skin, which splits around the margin of the body. At twenty-four days the males begin to issue, emerging from their scales, as a general thing, at night. At thirty days the females are about full grown, and embryotic young can be seen within their bodies; and at from thirty-three to forty days the larvæ begin to make their appearance.

From this it will be seen that there are several broods during the summer, and as the period of reproduction is protracted, all ages of young from several broods may be present at the same time on the same tree.

The insect will thrive in all parts of Ohio, and must be watched for among trees that have been bought either directly or indirectly from California, or from nurseries located east of the Allegheny Mountains, though this is not intended to imply that all eastern nurseries are infested.

REMEDIES.

If a tree or plant is severely attacked, and the scale has disseminated itself over the trunk, the cheapest way out of the trouble will be to promptly cut out and burn, otherwise the chances are that even if the scale is subdued, the tree will have been so badly injured that it will amount to little or nothing in the end, and will have cost the owner more than a healthy tree. If but the top is affected, this may be cut off and burned, the trunk thoroughly treated with remedial applications, and the stump grafted and a new top grown in this way. This has been done with perfect success in Ohio. If applied during mid-winter only, and to apple trees, ordinary commercial kerosene can be used with safety. It should be either sprayed on the trees or else applied with a brush, care being taken to get it into every crevice and wrinkle in the bark. The application may be repeated, but only during winter. For general use, nothing better has yet been found than a mixture of whale oil soap and water, made by dissolving two pounds of the soap in one gallon of water. This should be applied in spring, just at the time of the starting of the buds, in order to kill the young; as soon as the leaves fall in autumn, and several times during the winter. By far the most important factor in fighting the scale with this mixture is careful and thorough application, without which success need not be expected. As this San José scale is by all means the most serious insect pest that has ever menaced the fruit interests of Ohio, it goes without saying that prompt and thorough action is imperative. For nursery stock, although frequent applications of the whale oil soap mixture is advisable after the most seriously affected stock has been burned and thus put out of the way, large quantities of slightly affected stock may be more economically and as effectively treated by fumigation with hydrocyanic acid gas. This will be found all the more practical from the fact that many thousands of young trees of a marketable size can be brought together and heeled in within the limits of a small space that can be covered with a fumigating tent. This tent is made of eight-ounce duck, or ordinary brown or blue drilling, sewed carefully and painted and oiled in order to render it air-tight. This is placed over the trees to be treated, and under it, on the ground, in a vessel of

glazed earthenware, of one or two gallons capacity, is put for every 150 cubic feet of space covered by the tent, three fluid ounces of water, slightly more than one fluid ounce of commercial sulphuric acid, and one ounce by weight of fused potassium cyanide, fifty-eight per cent. pure, in lumps. Submit large trees to the fumes of this for half an hour, and small ones for half that time, if possible on cloudy days, or at night. If carefully applied, both of the above measures are thoroughly effective, but careless application of either one will result in partial success only. Not only should all trees known to be affected be treated, but any others adjoining, as the pest may be carried to these last by the winds, on the feet of birds or insects; even parasitic species may spread the scale in this manner. While, in my own experience, the scale usually spreads slowly from nursery stock, at least for the first two or three years, yet I am perfectly satisfied that if their progeny is left unmolested, the presence of two or three females on a tree will result in the death of the tree within three or four years.

TREES AND PLANTS AFFECTED.

Of trees and plants known to have been infested by the San José scale, the following is a list: Linden, euonymus, almond, peach, apricot, plum, cherry, spiræa, raspberry, rose, hawthorne, cotoneaster, pear, apple, quince, flowering quince, gooseberry, currant, flowering currant, persimmon, acacia, elm, osage orange, English walnut, pecan, alder, weeping willow, and laurel-leaved willow (from Asia).

APPENDIX.

OHIO BLACK-KNOT, YELLOWS AND SAN JOSÉ SCALE LAW.

[House Bill No. 508.]

AN ACT

To prevent the spread of yellows, a contagious disease among peach, almond, apricot and nectarine trees, and to prevent the spread of black-knot, a contagious disease among cherry, prune and plum trees, or any other contagious disease of fruit trees, also the infection known as the San José scale, and to provide measures for the eradication of the same.

SECTION 1. *Be it enacted by the General Assembly of the State of Ohio,* That it shall be unlawful for any person to keep, or permit to be kept upon his premises or upon premises under his charge or control, as owner or lessee or otherwise, any peach, almond, apricot or nectarine tree infected with the contagious disease known as yellows, or to keep any affected part of any cherry, plum or prune tree infected with the contagious disease known as black-knot, which affects one or more branches or any tree infested with San José scale or any of the fruit from any tree infected with peach yellows, or to sell or offer for sale, or to ship or permit to be shipped, to any person in any manner, any of said yellows fruit; that both trees and fruits so infected, except as aforesaid, shall be subject to destruction as public nuisances as hereinafter provided, and it shall be the duty of every person owning any fruit or having in their charge or under their control any fruit from any of the said trees so infected or any of such fruit so infected, except as aforesaid, and of every person having any of said fruit trees so infected in their charge or under their control as owner, agent, lessee or otherwise, to immediately destroy all trees so infected and all of said fruit so infected by burning the same; and whoever owning any of said fruit trees so infected, or whoever having any of the same in charge as agent, servant, employe or lessee or otherwise, shall fail or neglect to destroy all of the same within ten days after notice given to him by the township board of fruit commissioners, hereinafter mentioned, of such infected condition, shall be guilty of a misdemeanor, and upon conviction shall be fined in any sum not exceeding one hundred dollars; provided, however, that in case of the black-knot in any fruit tree, it shall be sufficient to cut away and destroy only the limb or part of the tree affected with black-knot, and destruction or the term destroy in this act shall be construed to mean destruction by fire.

It shall be sufficient to extinguish the San José scale with effective insecticides.

SECTION 2. It is further provided that any nurseryman, agent, dealer or other person, who shall sell, or offer for sale, any fruit trees for planting that are affected with any contagious disease, or infested with the pest known as the San José scale, or other obnoxious insect pest, shall be guilty of a misdemeanor, and upon conviction shall be fined not less than ten dollars nor more than one hundred dollars.

Whenever the disease known as peach yellows, also black-knot of the plum, cherry and prune are found to exist, not less than five freeholders in any township in Ohio may petition the township trustees to appoint a township board of fruit commissioners, recommending in said petition three or more of the most competent and best qualified persons known in said township for the position.

It shall be the duty of the trustees to speedily appoint for the township fruit commission, two of whom they consider the most capable freeholders in the township, who are growers of fruits liable to be diseased, one of whom must be familiar with the symptoms and nature of the disease aforesaid mentioned, and shall be the foreman of said commission. If the other member of the commission be unlearned, he shall diligently strive to become acquainted with the diseases they are to investigate. Where any serious difference arises between the two commissioners regarding the infected fruit or trees, the foreman of the nearest outside commission shall be called by the trustees as referee, and his decision shall be conclusive.

In case an expert cannot be found in the township, the trustees shall employ the nearest one outside the township, that they can find, whose term of service shall continue during the year. The commissioners shall hold office till the first of April following their appointment.

The township fruit commission shall be kept up as long as destructive diseases prevail and there is need of its existence, and the township trustees shall annually appoint the commissioners comprising it at their regular April meeting, and the said commissioners shall take their oath of office and file their acceptance with the township clerk.

To aid the trustees in their selection, five or more freeholders, who are interested in fruit growing, may petition them to appoint certain persons, whom they shall name and recommend in said petition, for the consideration of said trustees in making their appointment.

The compensation for each commissioner shall be two dollars and necessary expenses for each day's time engaged in the business of said office, and one dollar for each half day, all of which shall be allowed by the township trustees, and paid out of the funds of said township. It is further provided that in case a member of the township fruit commission proves seriously inefficient, and is unfaithful in the discharge of his official duties, on petition of five freeholders the trustees of said township shall investigate the complaints and charges made against said commissioner, and if they find good and sufficient cause, shall remove him and appoint another person to fill his place.

SECTION 3. The township clerk shall be clerk ex-officio of the township board of fruit commissioners, and he shall keep a correct and complete record of all their proceedings in a book to be provided him by the township trustees for that purpose, and he shall file and preserve all papers belonging to said board of commissioners, or either of them, and pertaining to their duties, all of which shall be a part of the public records of said township, and he shall receive such reasonable compensation for such services as the township trustees may allow.

It shall be the duty of the Ohio Experiment Station to publish a bulletin, that shall plainly give full and complete information regarding the causes, symptoms, devastating effects and cure or treatment of peach yellows, black-knot, San José scale, or other serious contagious diseases of fruits in sufficient quantity to supply every grower of fruit liable to these diseases, in the state. It shall be the duty of the annual township assessor to record the name and address of every person who owns or has charge of any peach, plum, cherry, prune, apricot or almond tree or trees, giving the name and number of each kind, and after the canvass of the township to file said report with the township clerk, who, with the aid of the foreman of the township fruit commission, shall inform the state experiment station of the number of bulletins needed in that township, and on receipt of the same the clerk shall mail or deliver one copy to each person who owns or has charge of any and all trees that are liable to serious damage from the contagious threatening diseases treated upon in said bulletin.

SECTION 4. It shall be the duty of said board of fruit commissioners upon or without complaint to carefully seek out, keep down and stamp out the contagious fruit diseases aforesaid mentioned, also the San José scale, or other noxious insect pest in every part of the township, during all seasons when the symptoms are plainly to be seen by either of them, to proceed together much as possible, without delay, and examine the trees and fruit supposed to be infected, and if any of said diseases are found to exist by said fruit commission, they shall place upon the diseased tree a distinguishing mark, and shall place upon the fruit a placard, and endorse thereon the diseased condition of such fruit, and they shall forthwith cause notice in writing to be served upon the owner of the same, if he be a resident within the county, and if the owner be not a resident of such county, then the written notice may be served upon the person having the same in charge for the owner or agent, employe, lessee or otherwise; such notice may be served personally or by copy left at the usual residence of any such person, and if no such person resides within such county upon whom service can be made, then such notice may be served by mail by being deposited in a post-office, postage prepaid, and addressed to the post-office address of such person wherever he may reside. Such notice shall contain a simple statement of the facts as found to exist, with an order of said board of fruit commissioners to remove and destroy by burning the trees so marked and designated, the whole tree, roots and branches where infected with yellows, and the branches infected with black-knot, and the fruit so marked by placard, within ten days from date of service of said notice, Sundays excepted, and if any person whose duty it is hereby made to destroy the same, fails, neglects or refuses to destroy the same as mentioned in such order of said commissioners, for a period of ten days after the service thereof, then the said commissioners be and are hereby authorized to enter upon the premises of any person and destroy all such fruit and trees so mentioned and found to be so diseased which they have marked or placarded, and said commissioners are hereby authorized to employ all help and secure all necessary means to so destroy the same, all of which shall be allowed by the township trustees and paid out of the township treasury. And in cases where said commissioners shall execute their own orders upon default of the person whose duty it is to execute the same, the costs shall be paid by the owner of the condemned fruit or trees, and in case of his failure to pay the same and all dues, after demand made by the trustees of such township, the said trustees shall certify the same, together with a penalty of 20 per cent. to the auditor of the county to be placed upon the tax duplicate, and the same shall become a lien upon the premises of such person from the time of filing the same with the auditor, and collected by the county treasurer as other taxes.

Any person who may be dissatisfied with the action of the township fruit commission in condemning his or her fruit trees, or diseased fruit, on the ground that said trees or fruit are not diseased, but sound and healthy, may appeal in writing, stating their grievance in full to the township trustees, who shall immediately refer the case, through the township clerk, to the professor at the Ohio Experiment Station, who is an expert in the line of complaint, whose duty it shall be to forthwith proceed to view the fruit or trees in controversy, and whose decision shall be final. All costs and expenses in the case shall be paid by the complainant, if defeated, and if not, by the trustees of the township in which the complaint is made.

SECTION 5. An act entitled "An act to prevent the spread of the yellows, a contagious disease among peach, almond, apricots and nectarine trees, and to prevent the spread of black-knot, a contagious disease among cherry, prune and plum trees, and to provide means for the eradication of the same, and to repeal an act entitled 'an act to amend section 1 of an act to eradicate the disease known as black-knot on plum and cherry trees,'" passed April 4, 1894, is hereby repealed.

CHARLES H. BOSLER,
Speaker pro tem. of the House of Representatives.
ASAHEL W. JONES,
President of the Senate.

Passed April 18, 1896.